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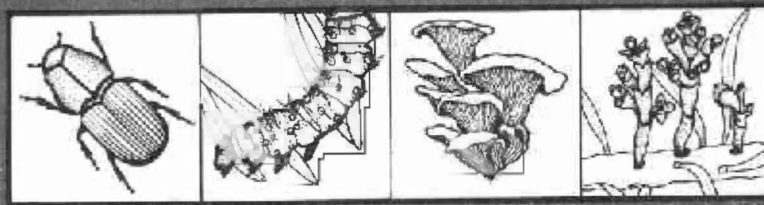

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MOUNTAIN PINE BEETLE INFESTATION IN PONDEROSA PINE ON CROW/NORTHERN CHEYENNE INDIAN RESERVATIONS, MONTANA, 1984

by

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ABSTRACT

The mountain pine beetle infestation existing on the Crow Indian Reservation (IR) since the early 1970's, and later developing principally in the western portion of the Northern Cheyenne IR, continued into 1984. Survey results indicate the infestation is still building on both Reservations. To help develop beetle management strategies appropriate for stands in eastern Montana, studies to demonstrate the effects of several partial-cut regimes have been initiated. That project and currently held management philosophies for mountain pine beetle in second-growth ponderosa pine are discussed.

INTRODUCTION

The mountain pine beetle (*Dendroctonus ponderosae* Hopk.), without doubt the most devastating pest of pine species throughout the western United States, continued to deplete second-growth ponderosa pine stands on the Crow and Northern Cheyenne Indian Reservations in eastern Montana during 1984. First recorded on the Crow IR in 1973 (McGregor and Kohler 1973), this infestation has grown from an estimated 500 faders in the Thompson and Corral Creek drainages in 1973 to more than 3,300 faders on over 1,200 acres stretching from Little Thompson Creek on the north to Ash Creek on the south in 1984. The Northern Cheyenne IR infestation was first observed aerially in 1980, but at that time existed only as scattered faders in a few drainages east of Lame Deer. In 1982, that infestation occurred in about 200 acres. By 1984, approximately 3,300 acres were infested. An estimated 1,400 faders were observed in scattered groups from Coal Creek east of Lame Deer to Dry Creek south of Busby in 1984. Though scattered throughout several drainages in the eastern part of the Crow IR and primarily the western portion of the Northern Cheyenne IR (figure 1), these infestations can be considered one continuing and increasing epidemic. Figures 1 and 2 illustrate its past 5-year growth.

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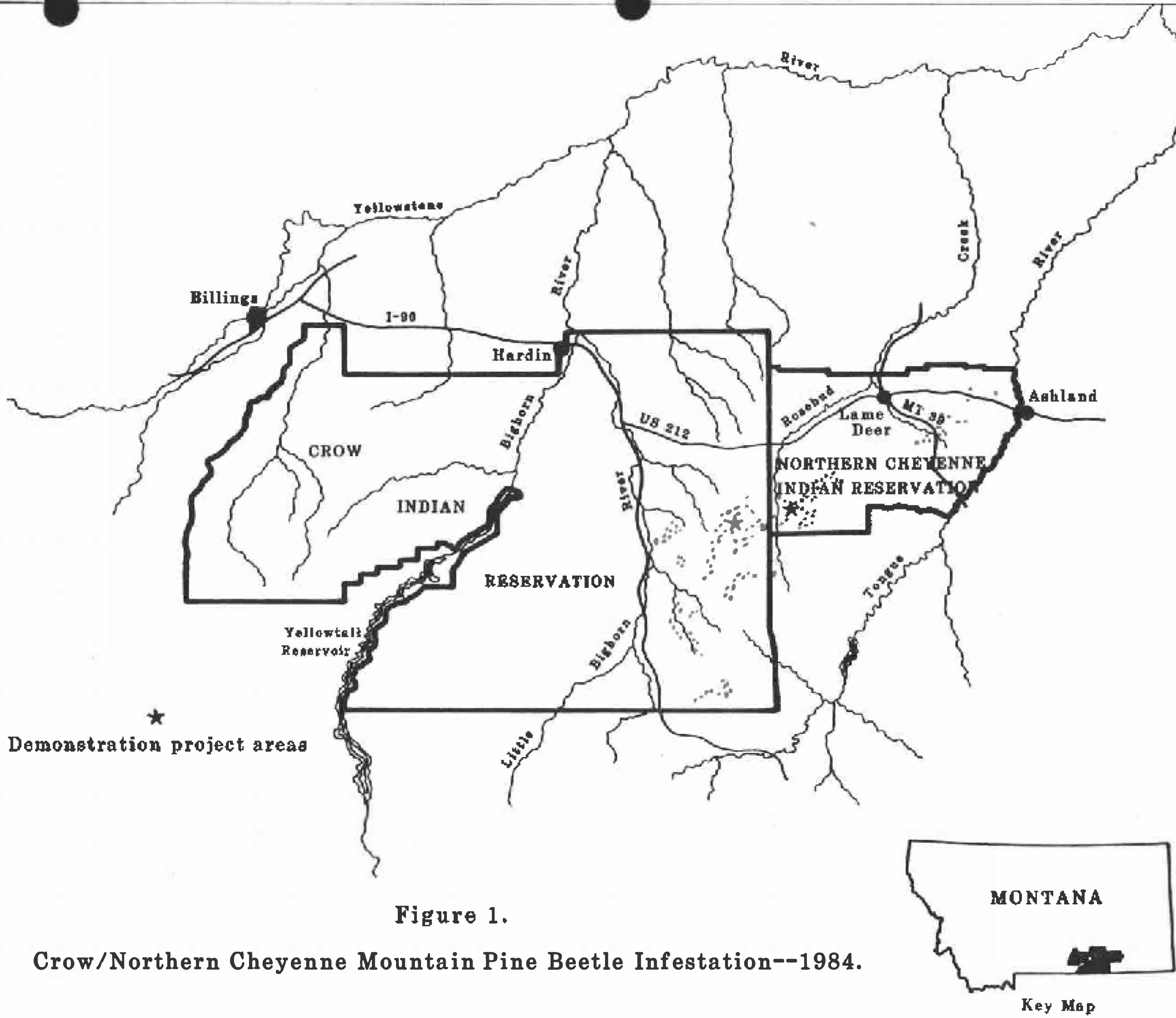

Figure 1.

Crow/Northern Cheyenne Mountain Pine Beetle Infestation--1984.

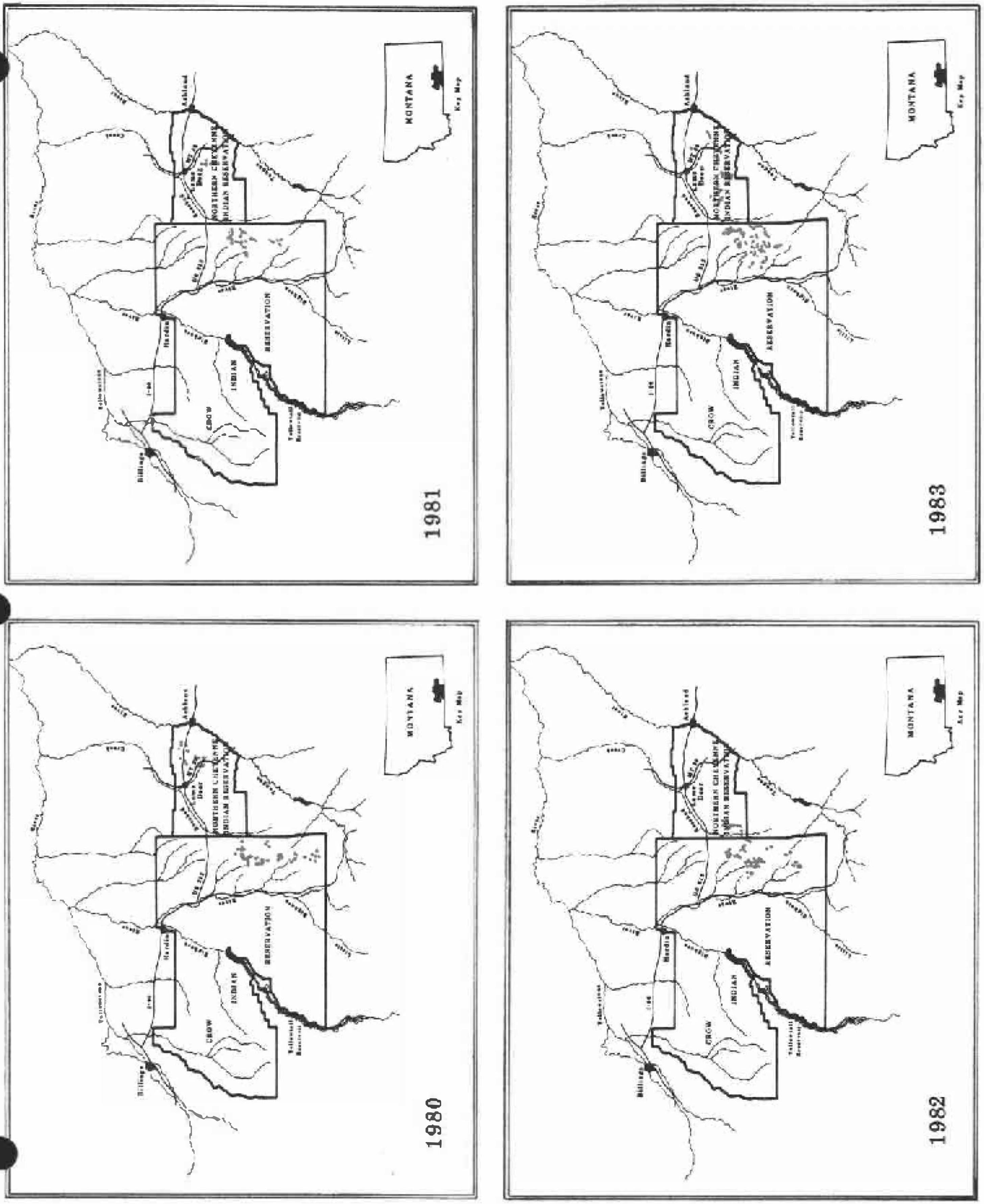

Figure 2. Crow/Northern Cheyenne Mountain Pine Beetle Infestation--1980-1983.

In 1984, we initiated a project to demonstrate the effectiveness of partial cutting to reduce beetle-caused mortality in these eastern Montana second-growth ponderosa pine stands (Amman et al. 1984). In addition, we collected information regarding stand conditions and beetle damage from a few selected sites on each Reservation. Data thus collected, our prognosis for the course of this infestation and current management recommendations are included in this report.

METHODS

The block design, cutting strategies and survey methods for the demonstration project previously mentioned will be described in a future report. For this evaluation, a description of the plots from which beetle data were collected will suffice. On each Reservation, eight adjacent 10-acre blocks were chosen in ponderosa pine stands either currently infested or imminently threatened by beetles. In each of those eight blocks, six variable radius (BAF 20) plots were established on a 3-chain by 3-chain grid. On each plot the following data were recorded: diameter (at breast height) of each "in" tree over 5.0 inches d.b.h, to nearest one-tenth inch; height of first three trees, to nearest foot; crown length of each tree whose height was measured; age, sapwood thickness, and phloem thickness from two cores each of two dominant or co-dominant trees; and regeneration data for trees less than 4.9 inches d.b.h. on a fixed radius (one three-hundredth-acre) plot. In addition, each tree was given a "condition" code to indicate its relation to mountain pine beetle, or in some cases other bark beetles: unattacked, current-year attack, previous-year attack, older dead (mountain pine beetle-caused), pitch-out (unsuccessful attack), current strip attack, previous-year strip attack, secondary beetle attack (current year), secondary beetle attack (older dead), and mortality from unknown causes.

Those blocks provided data from 48 plots on each Reservation. To supplement that data, we put in two sets of five plots each in other locally infested areas on each Reservation. Data collected on those plots were identical to that collected on the demonstration blocks except that crown heights were not measured, nor were trees bored. In total, we have information from 58 widely scattered plots on each of the two Reservations. Data from all plots were analyzed using the computer program INDIDS (Bousfield 1977).

RESULTS

Results from the demonstration project blocks (Corral Creek, figure 1) and the supplemental plots (Upper and Lower Corral Creek) for the Crow IR are shown in Table 1.

Those for the Northern Cheyenne IR (Skunk Creek, Trail Creek and North Fork Trail Creek, respectively) can be found in Table 2.

A combination of the two, showing combined data for the entire infestation, is shown in Table 3.

Table 1.—Status of mountain pine beetle infestation on Crow Indian Reservation, 1984[1].

Area		Unattacked trees	1984 attack	1983 attack	Older dead	Unsucc. attacks	1984 strip[2]	Older strip	1984 sec[3]	Older sec.	Unknown mort.[4]	Total	Total T/A[5]	BA[6]
Corral	T/A[7]	124	22	-	4	-	-	2	-	2	-	154	225	136
Cr.(1)	BF/A[8]	10,687	3,041	-	395	-	-	490	-	490	-	15,103		
Corral	T/A	80	33	41	22	-	-	-	-	-	-	176	530	165
Cr. (2)	BF/A	5,406	4,278	3,795	2,716	-	-	-	-	-	-	16,195		
Corral	T/A	115	-	-	5	-	-	-	-	-	-	120	165	107
Cr. (3)	BF/A	10,610	-	-	201	-	-	-	-	-	-	10,811		
Corral	T/A	101	25	-	-	-	-	-	-	-	-	126	151	130
Cr. (4)	BF/A		11,118	3,706	-	-	-	-	-	-	-	14,824		
Corral	T/A	262	62	18	12	4	-	-	-	-	-	358	315	291
Cr. (5)	BF/A		16,917	2,949	1,170	758	246	-	-	-	-	22,040		
Corral	T/A	148	-	-	3	-	-	-	-	-	-	151	148	123
Cr. (6)	BF/A		9,446	-	-	320	-	-	-	-	-	9,766		
Corral	T/A	214	-	-	-	-	-	-	-	-	-	214	513	139
Cr. (7)	BF/A	7,800	-	-	-	-	-	-	-	-	-	7,800		
Corral	T/A	155	5	-	8	-	-	-	-	-	-	168	355	122
Cr. (8)	BF/A		8,440	1,401	-	1,090	-	-	-	-	-	10,931		
Corral	T/A	150	18	7	7	<1	-	<1	-	<1	-	182	300	152
Cr. ($\bar{x}$)	BF/A	10,053	1,922	621	685	-	-	-	-	-	-	13,281		
Upper	T/A	128	16	14	7	-	-	-	-	-	-	165	165	156
Corral	BF/A	2,695	2,514	1,953	1,036	-	-	-	-	-	-	8,198		
Lower	T/A	145	*	127	69	24	-	-	-	-	-	365	229	197
Corral	BF/A	1,877	-	5,949	2,912	298	-	-	-	-	-	11,036		
Reservation	T/A	148	16*	18	12	2	-	-	-	-	-	196	282	156
($\bar{x}$)	BF/A	8,714	1,807	1,195	907	26	-	-	-	-	-	12,649		

*Some new attacks in <5 inch diameter class.
1 Data based on 58 variable radius (BAF 20) plots.
2 Strip attacks—attacked on one side of bole only.
3 Secondary bark beetle attacks.
4 Mortality due to undetermined causes.
5 Total T/A = Total number live trees per acre.
6 BA = Basal area in square feet per acre (live and dead trees).
7 T/A = Trees per acre ≥5 inches d.b.h.
8 BF/A = Board feet volume per acre.

Table 2.—Status of mountain pine beetle infestation on Northern Cheyenne Indian Reservation, 1984[1]

Area		Unattacked trees	1984 attack	1983 attack	Older dead	Unsucc. attacks	1984 strip[2]	Older strip	1984 sec[3]	Older sec.	Unknown mort.[4]	Total	Total T/A[5]	BA[6]
Skunk	T/A[7]	342	–	–	–	–	–	–	–	–	–	342	592	164
Cr (1)	BF/A[8]	5,408	–	–	–	–	–	–	–	–	–	5,408		
Skunk	T/A	453	–	–	–	–	–	–	–	–	–	453	902	173
Cr (2)	BF/A	4,865	–	–	–	–	–	–	–	–	–	4,865		
Skunk	T/A	335	–	–	8	–	–	–	–	–	–	343	734	172
Cr. (3)	BF/A	7,164	–	–	488	–	–	–	–	–	–	7,652		
Skunk	T/A	192	–	–	–	–	–	–	–	–	–	192	892	117
Cr. (4)	BF/A	5,812	–	–	–	–	–	–	–	–	–	5,812		
Skunk	T/A	217	–	–	4	–	–	–	–	–	–	221	667	154
Cr. (5)	BF/A	8,865	–	–	261	–	–	–	–	–	–	9,126		
Skunk	T/A	196	–	–	–	–	–	–	–	–	–	196	1,046	160
Cr. (6)	BF/A	9,006	–	–	–	–	–	–	–	–	–	9,006		
Skunk	T/A	252	–	–	–	–	–	–	–	–	–	252	852	131
Cr. (7)	BF/A	4,493	–	–	–	–	–	–	–	–	–	4,493		
Skunk	T/A	216	–	–	–	–	–	–	–	–	–	216	716	127
Cr. (8)	BF/A	5,617	–	–	–	–	–	–	–	–	–	5,617		
Skunk	T/A	275	–	–	2	–	–	–	–	–	–	277	800	150
Cr. ($\bar{x}$)	BF/A	6,404	–	–	94	–	–	–	–	–	–	6,498		
Trail	T/A	240	14	15	–	–	–	–	–	–	–	269	688	199
Cr.	BF/A	11,927	1,139	2,109	–	–	–	–	–	–	–	15,175		
N. Fork	T/A	85	91	4	2	2	–	–	–	–	–	184	424	174
Tr. Cr.	BF/A	9,708	4,593	376	488	544	–	–	–	–	–	15,709		
Reserva-	T/A	256	9	2	2	<1	–	–	–	–	–	268	758	156
tion ($\bar{x}$)	BF/A	7,165	494	214	120	10	–	–	–	–	–	8,040		

[1] Data based on 58 variable radius (BAF 20) plots.
[2] Strip attacks—attacked on one side of bole only.
[3] Secondary bark beetle attacks.
[4] Mortality due to undetermined causes.
[5] Total T/A = Total number live trees per acre.
[6] BA = Basal area in square feet per acre (live and dead trees).
[7] T/A = Trees per acre ≥5 inches d.b.h.
[8] BF/A = Board feet volume per acre.

Table 3.—Status of Crow/Northern Cheyenne mountain pine beetle infestation, 1984[1].

Area		Unattacked trees	1984 attacks	1983 attacks	Older dead	Unsucc. attacks	1984 strip[2]	Older strip	1984 sec[3]	Older sec.	Unknown mort.[4]	Total
Crow	T/A[5]	148	16	18	12	2	-	-	-	-	-	196
IR ($\bar{x}$)	BF/A[6]	8,714	1,807	1,195	907	26	-	-	-	-	-	12,649
N. Cheyenne	T/A	256	9	2	2	<1	-	-	-	-	-	268
IR ($\bar{x}$)	BF/A	7,165	494	214	120	10	-	-	-	-	-	8,040
Infestation	T/A	202	12	10	7	1	-	-	-	-	-	232
Average	BF/A	7,939	1,150	704	514	18	-	-	-	-	-	10,344

1 Data based on 116 variable radius (BAF 20) plots.
2 Strip attacks—attacked on one side of bole only.
3 Secondary bark beetle attacks.
4 Mortality due to undetermined causes.
5 T/A = Trees per acre $\geq$5 inches d.b.h.
6 BF/A = Board feet volume per acre.

In summary, more than 16 trees per acre were found to be currently infested on the Crow IR in 1984. That compared to 18 trees per acre killed in 1983. For the Northern Cheyenne IR, those figures were: Nine trees per acre killed in 1984 and two trees per acre killed in 1983. While the figures from the Northern Cheyenne IR are lower than those for the Crow IR, that portion of the infestation is several years "younger." Green stand data--data indicating trees per acre which may yet be attacked--indicate some stands on the Crow IR are being seriously depleted, while many on the Northern Cheyenne remain highly susceptible. We believe that unless infested and threatened stand conditions are altered--either through man's intervention or a natural disturbance such as fire--the beetle will ultimately kill a major portion of the merchantable component of those stands.

DISCUSSION

This evaluation is essentially an update of one done in 1979 on the Crow IR (Gibson et al. 1980). That one, likewise, had followed an earlier one prepared in 1974 (McGregor et al. 1974). These periodic evaluations show a continuing, almost chronic, infestation beginning about 1971 in overstocked second-growth ponderosa pine stands in the Wolf Mountains of the Crow IR. Since then, the infestation has continued its spread, though acres infested have varied from year to year (Table 4).

Beginning in 1980, a few faders were observed in the eastern portion of the Northern Cheyenne IR. There, small groups of widely scattered infested trees can still be found. The major part of the infestation has since developed in the western half of the Reservation as an extension of the Crow IR outbreak. Though ground surveys had not previously been done, annual aerial detection surveys have shown a steady increase in both scope and intensity of the infestation as it progressed from west to east. Table 4 shows acres infested and estimated number of trees killed on each Reservation during the past 5 years.

Table 4.--Aerial survey estimates of mountain pine beetle infestation on Crow/Northern Cheyenne Indian Reservations beetle infestation, 1980-1984.

Reservation	Year	Infested acres	Estimated faders[1]
Crow	1980	4,290	5,205
	1981	4,090	3,314
	1982	1,180	2,228
	1983	4,300	13,226
	1984	1,247	3,370
Northern Cheyenne	1980	-	37
	1981	-	237
	1982	200	301
	1983	1,760	600
	1984	3,313	1,460

[1] Fluctuations in estimates may be due more to different observers than actual variations in beetle populations.

In the past decade, much information about mountain pine beetle in second-growth ponderosa pine stands has been acquired: susceptibility characteristics, risk-rating guides, damage, and silvicultural control. However, most of this work has been in either the Black Hills or eastern Oregon. Some has been done in western Montana. We have extrapolated this data to stands in eastern Montana, without being certain how well those recommendations applied. For this reason, we feel it is imperative to gather on-site information applicable to eastern Montana stands--information we hope to obtain from the demonstration areas established there. From these data, we anticipate developing more precise management guides applicable to specific East-side ponderosa pine stands.

While much of our current knowledge has been gathered within the past 10 years, as early as 1941 Eaton (1941) found that ponderosa pines killed by mountain pine beetles had been growing slowly for the 10 years prior to their being attacked. Sartwell (1971) concluded that most beetle-caused mortality occurred in second-growth stands where density was high for a given site. He also noted many attacked trees were those with shorter than average crowns. That evidence suggested stand vigor may play a role in susceptibility to beetles, and led directly to the supposition that silvicultural control could be instrumental in outbreak prevention.

By 1975, Sartwell and Stevens (1975) had identified stand characteristics usually associated with beetle outbreaks:

A. species composition: pure or nearly pure ponderosa pine;

B. stand structure: essentially even aged;

C. stand age: 50 to 100 years;

D. tree size: 8- to 12-inch d.b.h.;

E. stand density: stem basal area generally in excess of 150 square feet per acre.

They concluded that stands thinned to accommodate local site conditions and management objectives, but kept below a "critical minimum" of 150 square feet per acre of basal area would likely not support major beetle infestations. Also in 1975, Griffin (1975) analyzed data from a study that showed in some western Montana stands, beetle-caused mortality could be reduced by thinning overstocked stands. He showed losses were lowest where stand basal area was 120 square feet per acre or less.

Soon thereafter, Sartwell and Dolph (1976) demonstrated the effects of thinning poletimber-sized stands. In their studies, beetle-caused mortality had been reduced by more than 90 percent in treated stands as compared to untreated ones. Several different thinning regimes were demonstrated; however, in the first 5 years following treatment, mortality was higher in unthinned areas than all thinned areas combined. Table 5 shows cumulative mortality data for those treated areas 15 years after treatment (R. E. Dolph, personal communication). Prior to treatment, stands were 55 years old and ranged from 4 to 8 inches d.b.h. Those stands are now 70 years of age and diameters range from 8 to 10 inches.

Table 5.--Treatment and resulting beetle-caused mortality in selected ponderosa pine stands in eastern Oregon, 1968-1983.

Stand spacing following treatment (feet)	Stand basal area following treatment (square feet/acre)	Amount of mountain pine beetle-caused mortality (square feet/acre)
Unthinned	173.0	144.5
12 x 12	116.8	84.9
15 x 15	85.8	24.5
18 x 18	61.8	16.7
21 x 21	35.0	5.0

In 1980, Stevens et al. (1980) published a risk-rating[1] guide for mountain pine beetle in Black Hills ponderosa pine. They identified three criteria as being critical to determining stand susceptibility to beetles. Table 6 shows these criteria, associated risk classes, and method for determining stand risk rating.

Table 6.--Risk-rating system for determining susceptibility of Black Hills ponderosa pine stands to mountain pine beetle attacks.

I. Determine risk value for each critical stand characteristic:

	Risk classes		
	1 = low	2 = moderate	3 = high
Stand structure	-	two-storied	single-storied
Average stand diameter (inches)	6	6-10	10
Stand density (square feet/acre)	80	80-150	150

[1]In this report, "risk" equates with stand susceptibility. Many authors now equate the term "hazard" with susceptibility; "risk" with anticipated loss.

II. Determine stand risk rating:

Risk values are multiplied together to determine risk rating for a given stand. For example: single-storied stand (risk 3), basal area 180 ft^2/ac (risk 3), average d.b.h. 11.2 inches (risk 3) has risk value 3 x 3 x 3 = 27. "Risk rating" (relative likelihood that a stand will support a major mountain pine beetle infestation) for stand determined from "risk value" (computed):

Stand risk value	Stand risk rating
2-6	Low
8-12	Moderate
18-27	High

Later, McCambridge et al. (1982) and Lessard (1982) suggested that these may be an over-simplication of the factors that determine stand susceptibility. McCambridge et al. (1982) showed a poor correlation between original stand basal area and percent of trees killed. Their data further demonstrated a relationship of percent pines killed with increasing diameter up to about 9 inches d.b.h. Beyond that diameter, mortality appeared to be random. They showed an additional correlation between dwarf mistletoe-infected trees and beetle-caused mortality. In this instance, more infected trees were killed than uninfected ones. Lessard (1982) suggested that beetle outbreaks be considered in two distinct phases: an "endemic phase" and an "epidemic phase." He maintained that in the "endemic phase" beetle attack was directed toward root-diseased trees or those weakened by other agents. During the "epidemic phase" attacks become random, but most mortality is sustained in stands with a preponderance of trees in the 7- to 13-inch diameter classes.

Despite some apparent discrepancies and unanswered questions, most agree that beetle mortality will be highest in those even-aged, single-storied, second-growth ponderosa pine stands of predominantly mid-range diameter classes. Where those stands are overstocked, the likelihood of an outbreak increases. McCambridge and Stevens (1982), in one of the most recent studies, showed that three ponderosa pine stands thinned to less than 90 square feet stem basal area per acre sustained little mortality from beetle attacks. Adjacent, unthinned stands continued to be adversely affected. These observations covered only a 3- to 4-year period, but results are consistent with those previously experienced.

RECOMMENDATIONS

Until results of the recently initiated demonstration project on the two Reservations are realized, our recommendations for treatment of the Crow/Northern Cheyenne mountain pine beetle infestation will be based on available information. Without such new data, which will help provide site-specific recommendations for eastern Montana ponderosa pine stands, we can only surmise that data from the Black Hills, eastern Oregon, or western Montana are applicable to those stands.

The first step in the management of these stands is the identification of management objectives. If some resource other than timber is the desired output from those affected stands, the current beetle outbreak may be of little consequence. In that case, it may be better, economically, to let the infestation run its course. If, on the other hand, it is desirable to manage the timber resource in infested or adjacent stands, steps must be taken to (1) identify susceptible, but uninfested stands; (2) reduce susceptibility in uninfested stands; (3) identify and treat currently infested stands; (4) continue to monitor treated and untreated areas for beetle population resurgence.

Uninfested stands should be risk rated according to the system developed by Stevens et al. (1980). This can be done with basic stand exam data. Stand treatment can then be prioritized on a highest risk first basis. Overmature or decadent stands should be removed. Immature but overstocked stands should be thinned. Current recommendations would suggest thinning to a residual basal area of approximately 80 square feet per acre or less. Where preferable, thinning can be done on a spacing basis. Dependent upon average stand diameter (quadratic mean diameter), a residual basal area of 80 square feet per acre would result in spacings of 17 by 17 feet for 10-inch trees or 21 by 21 feet for 12-inch trees. Recommended residual basal area may vary with local site conditions. Better sites can probably accommodate higher stocking--poorer sites, correspondingly less.

Infested stands will need to be treated according to level of infestation and sound silvicultural practices for the site. Stands with a large amount of past mortality or presently infested trees should be regenerated. Lesser amounts of beetle-affected trees may imply salvage or sanitation cuts to remove dead or threatened trees. These partial cuts will not only immediately reduce losses to the beetle by altering the microenvironment of the stand, but will improve growing conditions for residual trees, providing longer protection as well.

Stevens et al. (1974) outlined a timetable for a management program to minimize losses to the beetle when an infestation is underway. The tasks they identified plus modifications based on information obtained since 1974, and approximate times for accomplishment are as follows:

Year	Task
1	Determine boundaries of area to be included. Arrange for handling as a unit.
	Salvage or fall and burn infested trees over entire area. (Where infested groups are small, pheromone baits and/or traps may be used to contain beetle populations.)
	Locate areas in which thinning is needed. Thin to approximately 80 square feet basal area per acre or less, depending on site factors.
2	Continue salvage and/or other management options.
	Finish thinning.

3	Salvage and/or other management options.
4+	Maintain surveillance. Salvage if needed.
10+	Reevaluate treated area. Thin where necessary to maintain desired stocking.

Using these guidelines, they estimate at least 3 years may be required to significantly reduce beetle-caused mortality.

We realize silvicultural management of stands to reduce beetle populations is dependent upon local market conditions and the manager's ability to sell an advertised sale. Unless trees planned for removal can be sold, reduction of beetle populations will not come cheaply. Still, the land manager must realize that unless overstocked stands are managed, the beetle will likely impose a "management regime" upon them. Dependent upon management objectives, that may not be the most economically desirable alternative.

Finally, a few alternatives exist that are a more "direct" control approach to beetle management. These include falling and burning infested trees, the use of chemical insecticides in both remedial and preventive roles, and the still developing use of semiochemicals--used either in conjunction with logging, hanging traps, or insecticides for the management of beetle populations.

Falling and burning of infested trees may have some short-term beneficial effects where infested groups are small. This approach must be considered a stop-gap measure only, since susceptible stand conditions remain (Sartwell and Dolph 1976).

Chemical insecticides have been used as remedial measures, but these, while locally effective, have proven to be economically unacceptable in the long term (Klein 1978). As a preventive treatment, however, carbaryl insecticide has proven effective and both biologically and economically efficient (McCambridge 1981). While efficacious, this usage is limited to high-value situations such as campgrounds, homesites, etc. An additional, promising use for carbaryl involves its use with pheromone baits to produce "lethal trap trees." Where infested groups of trees are small and undesirable or uneconomical to remove, surrounding susceptible trees could be sprayed with carbaryl, then baited with pheromones prior to beetle flight. Such treated trees attract and kill most or all the beetles in that infested group. In recently completed tests, beetle populations have been effectively reduced without removing or losing additional trees (Peter Hall, personal communication).

A newer development involves the use of semiochemicals--chemical messengers used to contain or manipulate beetle populations. Coupled with logging, these techniques have been used successfully in managing beetle populations in lodgepole pine forests (Borden et al. 1983, Borden and Lacey 1985). Their use in ponderosa pine stands, while as yet largely untested, holds promise. We believe they have the potential to reduce beetle populations to endemic levels in lightly infested stands.

The availability of semiochemical baits has resulted in their immediate incorporation into beetle management programs. They can be integrated with harvesting, either singly or in combination with three principal objectives:

1. Containment of infestation by baiting trees on a grid or perimeter basis so infestations intensify in a limited area amenable to sanitation/salvage logging.

2. Post logging mop-up of residual infestations by baiting perimeter trees following sanitation/salvage clearcuts; or by strategically baiting residual trees, after selective baiting and cutting, to verify effectiveness of such treatments.

3. Concentration of infestations by baiting trees in lightly infested blocks selected for logging in an attempt to attract beetles from similar adjacent stands into the cut block (Borden and Lacey 1985).

One final use of semiochemical baits includes their incorporation into multiple-funnel hanging traps (Lindgren 1983). These collapsible, easily transported, and reusable traps can be placed in selected areas to monitor and possibly reduce beetle populations to endemic status where those populations are low. Traps may also be placed around sawmills in sensitive or susceptible areas to monitor and trap beetles emerging from log decks.

Not all baiting and/or trapping programs can be expected to be successful. Some may require additional modified treatment. We are confident, however, that the use of semiochemicals can and will be a powerful tool in the management of beetle populations infesting or threatening susceptible host stands.

CONCLUSION

In summary, the Crow/Northern Cheyenne mountain pine beetle epidemic is expanding. Some drainages, particularly on the Crow IR, have sustained large amounts of tree killing and populations are beginning to subside. In others, populations are building rapidly. On the Northern Cheyenne IR, many areas are not yet infested but contain highly susceptible stands. Now is the time to develop management objectives, identify stands in which treament is both needed and desired, then bring those stands under appropriate management. Significant reductions in beetle-caused mortality will not be achieved quickly; nor will their costs be low. With timely action, however, they are attainable.

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